B U L L E T I N

of the

United States Institute for Textile Research, Inc.

Vol. I. July, 1931 No. 6

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Research Abstracts

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Secretary's Temporary Office
65 Franklin St., Boston, Mass.

BULLETIN

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Secretary's Temporary Office
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T. R. I. BULLETIN

An Official Publication of
United States Institute for Textile Research, Inc.

Vol. I Boston, Mass., July, 1931 No. 6

SUGGESTIONS WANTED

This, the sixth monthly issue of T. R. I. Bulletin, would normally complete its first volume, but because of its relatively small size, mimeograph form and immaturity its first volume will be of twelve issues. When that is completed the editors may have the courage to "point with pride" to an inventory of accomplishments, and to present a prospectus of "better things to come."

Being conscious of the adolescence of T. R. I. Bulletin they are moved at this time to direct attention to the fact that its parentage is as much that of every member of U. S. Institute as theirs, and that responsibility for its development and for the character of service it performs is also communistic. They are not looking for a "five year plan," but they do expect that each member of the Institute will give them the benefit of ideas for improving T. R. I. Bulletin service and will make full use of the service it gives. Certain inadequacies are evident and will be rectified as soon as possible, particularly the coverage of chemical subjects. In the meantime this shortcoming may be met, in part at least, by reference to Chemical Abstracts and to the dye and chemical publications that abstract such literature.

A Suggestion Given

With the modesty becoming one so adolescent we would call attention to the fact that the Secretary's office and certain members are carding and indexing the abstracts and bibliography as each issue appears, it being their belief that eventually this card index of textile research literature and facts will be of the utmost value for reference purposes. It is possible that we may be obliged to furnish duplicates of these card indexes to members as a special service in the future, as do some other similar organizations. Until such a demand arises the Secretary's office can furnish a limited number of back issues to members whose files are incomplete.

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RESEARCH PROMOTION MEETINGS

The Directors at their meeting in June discussed preliminary plans for a series of meetings next Fall, that, for the want of an equally short and inclusive term, were defined as a Membership Promotion Campaign. From the financial standpoint that term is apt and adequate, but from the broader viewpoint of the service to the textile industry for which U. S. Institute was organized it is not only inadequate, but misleading.

This series of meetings to be held in Greenville, S. C., Philadelphia, Boston and New York City is designed to give non-members of U. S. Institute an opportunity to learn personally of just what the Institute has done and plans to accomplish. It is an educational movement both as to Institute activities and as to the industry's need of scientific research as an individual and cooperative undertaking. It is a research promotion campaign, not merely a membership promotion plan.

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CLASSIFIED INDEX
of
Abstracts and Bibliography
(Arranged Alphabetically by Major Subject)

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ABSTRACTS

INVESTIGATION OF THE HYDROLYSIS OF CELLULOSE ACETATE.- D. Kruger.
Melliands' Textilber., Mannheim, 1929, No. 3.

In this paper is reviewed the literature concerned with the alkaline hydrolysis of cellulose acetate and related substances such as triacetin. Attempts to calculate hydrolysis constants using the first order reaction equation did not give values which were within limits close enough to be significant. The author believes this to be caused by the heterogeneous nature of such hydrolysis. He has shown, however, that the hydrolysis of material prepared from cotton and wood pulp is approximately the same. He further shows that the rate of hydrolysis of cellulose acetate with alkali is dependent on the swelling action of the medium in which such hydrolysis is carried out. There is further indicated the much greater resistance of acetone-soluble cellulose acetate to acid than to alkali and the effect of swelling on the rate under such conditions. It is concluded that the rate of hydrolysis of cellulose acetate depends on the swelling action in the same manner as cellulose nitrate. (Monthly Abstract Bulletin, Kodak Research Laboratories, June, 1931.)

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CELLULOSE BUTYRATE.- G. von Frank and H. Cohn.
Cellulosechemie, 12: 68, March 8, 1931.

Cotton cellulose ("nitration paper") is treated with 90 per cent formic acid for 24 hours at 20 degrees, pressed off, washed free of acid and air-dried. It contains 6.9 per cent HCOOH. This is introduced into a mixture of 12 gm. zinc chloride, 75 gm. butyric anhydride, and 20 gm. butyric acid and maintained at 40 degrees for about 20 hours. The product is precipitated with water and thoroughly washed with hot water and dried. It is redissolved in 93 per cent butyric acid and heated at 90 degrees for 30 hours and precipitated with water. This treatment hydrolyzes the residual formic acid, about 3 per cent. A dilute solution of the cellulose butyrate in acetone is prepared and filtered. The filtered solution is precipitated in water. Yield is 18.5 gm. C_3H_7COOH 64 to 55 per cent. The formic acid may be displaced by excess butyric acid and the mixed ester hydrolyzed directly. Cellulose butyrate films are shown to exhibit a lower tensile strength and higher elongation than cellulose acetate. (Monthly Abstract Bulletin, Kodak Research Laboratories, June, 1931.)

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PREPARATION OF CELLULOSE NITRATE BY A MIXTURE OF PHOSPHORIC AND NITRIC ACIDS.- E. Berl and G. Rueff.
Cellulosechemie, 12: 53, March 8, 1931.

Ramie fibre was used in the work because it is more satisfactory than cotton cellulose in x-ray technique. Studies were made on the effect of changing ratios of nitric to phosphoric acids on the nitrogen content of the resulting products. Best results were obtained with equal molecular proportions of the acids at 19 degrees + 1 degree for 4 hours, using a ratio of cellulose to acid of 1:60. Under these conditions the product contains 14.01 per cent nitrogen. The phosphoric acid contained also 3.15 per cent phosphorus pentoxide and the nitric acid was of 99.85 per cent concentration. When small amounts of water are present the nitrogen content falls below 14 per cent. Contrary to results obtained when using sulfuric-nitric acid mixtures, phosphoric-nitric acid mixtures cause less breakdown of the micelles, attributed by the authors to the fact that phosphoric acid does not saponify cellulose nitrate and that in the presence of small amounts of phosphorus pentoxide behaves as meta-phosphoric acid, which is a stronger dehydrating agent and therefore promotes the reaction better than sulfuric acid. Before the true esterification, the atom grating of the cellulose is surrounded with hydrocellulose. The strong swelling facilitates the

entry of the nitric acid into the micelles as well as into the fibres, whereby a homogeneous nitration is obtained. The trinitrate exhibits a diagram similar to less highly esterified products, "a proof that mono as well as dinitrates have no individual crystal grating." The nitrates are said to possess superior stability and purity. (Monthly Abstract Bulletin, Kodak Research Laboratories, June, 1931.)

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THE SWELLING OF CELLULOSE AND ITS AFFINITY RELATIONS WITH AQUEOUS SOLUTIONS. PART III--THE PREFERENTIAL ABSORPTION OF SODIUM HYDROXIDE FROM DILUTE SOLUTION AS A CHARACTERISTIC PROPERTY OF CELLULOSE, AND AN INDICATION OF PREVIOUS MERCERIZATION OR OTHER SWELLING TREATMENT.- Sidney Maurice Neale, M.Sc. Journal Textile Institute, Vol. 22 - 6, pp. T320-338. June, 1931.

In the present paper the preferential absorption of alkali, calculated from the change in concentration of the liquid phase on the assumption of a constant mass of water therein, is put forward as a characteristic property of cellulose. In the first paper of this series, however, it was pointed out that this quantity probably has little fundamental significance and is to be regarded as dependent, not only on the amount of sodium in chemical combination with the cellulose, but also to a smaller extent on the amount of water imbibed by the cellulose phase. This latter quantity is not as a rule exactly known, but rough values may be obtained from the data of Coward and Spencer, and by means of these the combined sodium may be calculated from the observed preferential absorption.

If this is done it is found that the preferential absorption is less than the combined sodium in a ratio varying between 0.65 and 0.75, according to the possible variations of an alkali concentration between N/10 and 5N, and of water imbibition between 4 and 16 moles per mole. Over such an extreme range this variation in ratio may be regarded as small enough to justify the use of the preferential absorption as an approximate measure of the reactivity of celluloses towards alkali.

In reagents such as caustic soda, zinc chloride, or sulphuric acid of suitable concentration and temperature, cotton cellulose may swell to a great extent. If the swelling, as judged by change of dimensions, is about equal to or more intense than that afforded by mercerizing caustic soda at the ordinary temperature, the washed and dried product absorbs nearly three times as much alkali as does the unswollen material. Solutions of cuprammonium hydroxide just below solvent concentration are, however, capable of causing great swelling without a corresponding large increase in the activity of the product towards alkali. The rayons, representing cellulose that has passed through a phase of complete dissolution, absorb more alkali than any samples of cellulose that have merely been swollen.

The application of tension to yarn or cloth restrains the swelling of the hairs, and leads to a product of lower reactivity towards alkali. Drying at a high temperature also reduces the alkali absorbing power of certain mercerized cottons of high activity. Cotton mercerized in a grey state and then scoured by boiling with a dilute solution of caustic soda shows a lower alkali absorption and a lower reactivity towards alkaline hypobromite than cotton mercerized in the scoured condition. Measurement of its capacity for absorbing dilute alkali has been used to investigate the reactivity of cotton that has been treated with caustic soda solutions of varying concentration. With caustic soda of concentrations above 15% the product has a fairly uniform level of activity, but the results show that more than three minutes' immersion in the mercerizing alkali is required to attain the maximum effect with solutions more concentrated than 40 percent. When solutions of caustic soda of higher concentration than 25 per cent are used for mercerizing, a less active product is obtained if the alkali is washed off by a solution of brine, than when water only is used for washing. It is to be presumed that the use of brine prevents the transient

swelling that takes place when cellulose in equilibrium with concentrated alkali is suddenly immersed in water. This effect has been described in a previous paper.

The determination of the amount of alkali absorbed by mercerized cotton prepared with an extremely slow washing process has been used to show that mercerization does not consist essentially in the development of an imperfectly crystalline arrangement due to rapid coagulation of cellulose from a state of semi-solution.

A method for the routine examination of samples of cotton goods that have passed through the industrial process of mercerization could be based on the determination of the capacity of the material for absorbing sodium hydroxide. It has, however, been found that similar information as to the state of the cellulose is afforded in a manner less exacting experimentally by the determination of the preferential absorption of barium hydroxide from a quarter normal solution. The technique of this test, and some of the results obtained with it are described in this paper, but for comparison the baryta absorption ratios of some of the cotton samples are given along with the soda absorption ratios in the present paper. A number of charts are included and a bibliography of 16 items largely from the Shirley Institute Memoirs and the Journal of the Textile Institute are given. (S)

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NOTE ON THE RELATIONSHIP OF FIBRE FINENESS AND WOOL QUALITY IN COMBED TOPS.- S. G. Barker and C. G. Winson.
Journal Textile Institute, Vol. 22 - 6, June, 1931, pp. T314-319.

The paper points out that it has been found that a linear relationship exists between the logarithm of the average fineness of a top, expressed as the weight of 10 metres of fibre, and its position in the scale of qualities for equal intervals of the latter. An equation is derived from which it is seen that the scale of fineness is in reality a series of values in geometric progression with a constant ratio: $r = e^{\frac{1}{6.43}}$

Discussion of the French, German and Italian standards follows and the formulae for these relationships are given. A bibliography of six items is appended one of which from the Melliand Textilberichte, Vol. II - 7, is of particular interest. (S)

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A CONTRIBUTION TO THE THEORY OF MILLING. PART I--A METHOD FOR MEASURING THE SCALINESS OF WOOL FIBRES.- J. B. Speakman and Emma Stott.
Journal Textile Institute, Vol. 22 - 6, June, 1931.

In this paper it is stated that a true forecast of the relative milling properties of different wools cannot be made unless their scaliness has been measured, their swelling properties investigated and the influence of fibre-length on milling determined. The present paper represents the first of a series of investigations undertaken to give quantitative expression to the various factors involved in milling shrinkage; it describes a method for measuring the scaliness of wool fibres. Marked differences in the scaliness of various wools have been revealed and their different milling properties must, to some extent at least, be referred to this cause. No strict correlation between scaliness and milling efficiency ought, however, to be expected in the case of radically different types of wool because scaliness is not the only factor concerned in the milling process.

Part II of this paper will be devoted to a discussion of the two remaining factors which may affect the relative milling properties of different kinds of wool; fibre-swelling and alterations in scaliness caused thereby, and fibre-length. (S)

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THE SULPHUR CONTENT OF SOME SOUTH AFRICAN WOOLS.- F. N. Bonsma.
Journal Textile Institute, Vol. 22 - 6, June, 1931, pp. T305-313.

The paper is concerned largely with the variations of sulphur from the genetic and the nutritional points of view. A considerable variation in the sulphur content in the wools from different individual sheep fed on the same diet was found, and this fact suggests that the sulphur content is an inherited characteristic. Further studies, however, indicate that there is a change in sulphur content with rain fall and hence the nutritive value of pasturage. An interesting chart covering 15 months from September of one year through January of the second succeeding year is given. Preliminary data are given concerning the relationship of sulphur content to the cross sectional area and contour, but insufficient values are available to enable conclusions to be drawn. A bibliography of 14 items is appended. (S)

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TIMING AND SCHEDULING INSTRUMENTS.- M. F. Behar.
Instruments, Vol. IV - 6, June, 1931, pp. 309-356.

This is Chapter 14 of the proposed hand-book of Industrial Instruments and lists a number of devices with detailed discussions which should be of interest to anyone engaged in time study or control work whether in textile testing or manufacturing, and is a continuation of the same subject from the previous month's issue. The outline includes time indicators both for elapsed time and indicating; time recorders both chartless and graphical; chronographs and pyrometric cones; single duty controllers; sequence or multi-operational controllers; condition-time-curve controllers; and combination controllers. The illustrations are excellent and just sufficient descriptive matter is included to give a good idea of the operation, field, and usefulness of the equipment listed. Particularly good treatment covers the operational controls and several typical processes are outlined by chart and diagram. The article should prove of immense interest to anyone concerned with automatic control of testing or processes, where time is an item, however complicated or variable conditions may be. (S)

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Copies of Matter Abstracted

The Secretary will endeavor to provide members with mimeograph or photostat copies at cost of articles and other matter abstracted that they cannot obtain otherwise. Most of the publications, however, may be consulted at leading public or other libraries, and most of the books, pamphlets and periodicals may be obtained from their respective publishers.

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BIBLIOGRAPHY

DEPENDENCE OF THE SOLUBILITY AND STRENGTH OF CERTAIN CELLULOSE DERIVATIVES UPON CHEMICAL COMPOSITION.- M. Hagedorn and P. Moller.
Cellulosechemie, 12: 29, Feb., 1931.

The authors discuss the properties of cellulose esters, mixed esters and ethers. Tables of solubility, tensile strength and elongation of numerous cellulose derivatives are given. Esters of saturated and unsaturated organic acids are treated separately; cellulose ethers are briefly discussed. The article is an excellent compilation of properties of the available cellulose derivatives. The discussion of the influence of the various radicles on the properties of the cellulose derivatives are interesting. (Monthly Abstract Bulletin, Kodak Research Laboratories, June, 1931.)

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TECHNOLOGY OF CELLULOSE ACETATE.- Aladin.
Plastics, 7: 142, March, 1931.

A complete review is given of progress in the preparation of cellulose acetate as shown in the world's patent literature during the last decade. (Monthly Abstract Bulletin, Kodak Research Laboratories. June, 1931.)

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THE EFFECT OF TWIST UPON THE RAYON PROPERTIES OF YARN.- H. J. Ball.
Bulletin Lowell Textile Institute, series 34, #4 (May, 1931).

A summation of two researches concerned with the measurement of change in strength, stretch and denier for the four commercial classes of rayon yarn. (150 denier - 40 filament). It is shown that there is in general a gradual decreasing in strength with increasing twists; an increase in per cent stretch and a slower increase in denier. Twist varied from 5 through 35 turns per inch. Each plotted point on the three charts given is the average of 100 tests. (S)

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TWIST: PREVALENT MISCONCEPTIONS IN THE SEWING THREAD TRADE.- Robert Wilson.
Textile World, Vol. 79 - 25, (June 20, 1931) pp. 32-35.

A brief discussion of the present lack of uniformity of definition for the direction and amount of twist in yarn and thread. The question of balance is mentioned and several practical solutions are outlined. (S)

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BEHAVIOR OF DYESTUFF PARTICLES WITHIN CELLULOSIC MATERIALS.- A.J.Hall.
Cellulose, 1: 275, Dec., 1930.

This is a discussion of differences in absorption of dye particles to viscose and cotton, and the mechanism of penetration and diffusion of the dyestuff in and between the micelles of fibres. (Monthly Abstract Bulletin, Kodak Research Laboratories, May, 1931.)

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CHEMICAL PROCESS CONTROL: NEW APPARATUS FOR.
The Melliand Textile Monthly, Vol. III - 3, (June, 1931) pp. 231-234.

A description of three sets of apparatus for the measurement respectively of active or available chlorine; reducing power as compared to standard pure dye solid hydrosulfite content, and the percent fatty acid of certain soap products. (S)

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DEVELOPMENT OF RAYON DYESTUFFS: I. ACETATE RAYON DYES.- R. Brightman.
Ind. Chem., 6:500, Dec., 1930.

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CONTACT SWITCH: A NEW VACUUM.
Instruments, Vol. IV - 6 (June, 1931) p. 358.

A description of the Burgess Vacuum Contact handling up to 6 amperes continous load, or 8 amperes intermittent load, up to 220 volts. It may be operated by hand, mechanically or by electric relay and should be of use in many types of testing equipment. It is stated that one of these contacts has been operated 10 times per second, 124,000,000 times without break-down. (S)

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THE GROWING IMPORTANCE OF THE MICROSCOPIC ANALYSIS OF TEXTILES.- E.R.Schwarz.
Textile American, Vol. 56 - 1 (July, 1931) pp. 13-15.

A brief discussion of the applications and value of the modern types of textile microscopes to the research problems of the industry. Two of the latest instruments--presented on the market for the first time this year--are illustrated. (S)

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MEASURING MICROSCOPES.
Instruments, Vol. IV - 6, (June, 1931) pp. 360-361.

Several new microscopes introduced by Zeiss are illustrated and described. They are intended for measuring and are somewhat lighter and more general of application than many of the instruments hitherto put on the market. (S)

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PORTABLE INSTRUMENT FOR MEASURING AIR PERMEABILITY OF FABRICS.- H. F. Schiefer and A. S. Best.
Bureau of Standards Jnl. Research, 6: 51, Jan., 1931.

The specimen, seven inches square, is clamped between two rings under a slight tension. Air is drawn through the fabric and through a calibrating orifice by a suction fan. The volume of air passing through the fabric at a given pressure-drop is thus obtained. The measurement is accurate to ±2%. It is shown that the variation in air permeability because of non-uniformities in the cloth is greater than the experimental uncertainty. (Monthly Abstract Bulletin, Kodak Research Laboratories, May 1931.)

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PRECISION IN SERIPLANE INSPECTIONS.
Testing. (June, 1931), pp. 4.

A brief discussion of the necessity for careful examination of a testing problem to determine the number of observations necessary and the number of samples needed for the determination of such a factor in silk as evenness. Samples of several possible determinations are given. (S)

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SPECTROPHOTOMETRIC MEASUREMENTS IN THE DYESTUFFS INDUSTRY.- Carl Z. Draves.
American Dyestuff Reporter, Vol. 20, #12, (June 22, 1931), pp. 389-392, 415.

A paper presented before the Optical Society of America, Feb. 26, 1931, in which the use of spectrophotometric measurements in the dye-stuff's field field is discussed. The author emphasizes the fact that mechanical methods should not be substituted to too large an extent for personal accuracy. He further advises when it would be wise to use spectrophotometric apparatus and when such use should be avoided. (S)

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SPRING TESTING MACHINE. (ELASTICOMETER).
Instruments, Vol. IV - 6, (June, 1931), pp. 362.

A convenient device for testing and calibrating small springs. The maximum load capacity is 5 pounds. The instrument should prove of value to anyone concerned with testing equipment employing small springs for the measurement of load. (S)

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STRETCH AND SHRINKAGE TESTING APPARATUS.
Instruments, Vol. IV - 6, (June, 1931), pp. 360.

An apparatus by Schopper of Leipzig, Germany, designed particularly for paper but applicable to textiles as well. The sample is stretched between clamps and is arranged for immersion in a container of liquid when necessary. Variable tension may be employed and extension or contraction is indicated by a pointer on scales reading from 0 to 5 mm. by 20ths. (S)

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WOOL, WOOLENS AND WORSTEDS THROUGH THE MICROSCOPE.- E. R. Schwarz.
Melliand Textile Monthly, Vol. III - 3, (June, 1931), pp. 244-246.

The first part of an article concerning the applications of microscopic equipment to the study of wool fibre as such and to its uses in yarn and fabric. General bibliography of recent work is appended. (S)

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X-RAY TUBE: NEW POWERFUL.
Instruments, Vol. IV - 6, (June, 1931), pp. 365.

A brief illustrated description of the new x-ray tube developed by Doctor Coolidge of the General Electric Company, Schenectady, N. Y. The tube works at 900,000 volts and is built in two sections. It is capable of photographing material through 4" of iron and will materially shorten the time of exposure necessary for the production of x-ray diagrams for fibres or other material. (S)

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BIBLIOGRAPHIC SERIES (4th supplement to Bulletin #2).
Mellon Institute of Industrial Research. (1931)

A list of books, bulletins, journal contributions, and patents by members of Mellon Institute during the calender year 1930. Three items are of particular interest in connection with textiles:

"New Chemical Products in the Textile Industry." Harvey & Reid, Melliand, Vol. I (1930) pp. 1806-1809.

"Moth Proofing". L. E. Jackson. Industrial Engineering Chemistry, Vol. 22, pp. 398-399.

"Research Improves Textile Oils." R. B. Trusler. Textile World, Vol. 77 - 10, pp. 37-41, 80. (S)

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TEXTILE RESEARCH AT MELLON INSTITUTE.- Lawrence W. Bass.
Textile World, July 26, 1930. (Available from Mellon Institute as a reprint.)

The following fellowships are briefly discussed: Textile Fellowship (primarily concerned with the underwear field and flax); Cotton Yarn Fellowship (Durene technology); Velvet Fellowship (upholstery and physico-chemical properties of mohair); Laundry and Dry Cleaning Fellowships; Hat Making; Pressing Machinery Fellowship; Sleeping Equipment Studies; and Garment Fellowship. (S)

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WHAT STATISTICS ARE NEEDED IN TEXTILES.- H. S. Davis.
Textile World, Vol. 79 - 24, pp. 20-21, 31.

The author endeavors to present to the industry a picture of "Integrated Statistics" which would meet the need for the development of informative data upon the basis of which it may operate most effectively. (S)

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BOOK REVIEWS

COTTON DOUBLING AND TWISTING.- Sam Wakefield.
C. Nicholls and Co., Ltd., Manchester, Eng.

This is the second edition of the four volume work published in 1915. There has been a good deal of rearrangement and amplification of the original material, but the previous form of four volumes comprising four sections each is retained. Section 1 concerns yarn testing and sampling; section 2 deals with doubling and winding; section 3 describes flyer and ring twisting; section 4 outlines twiner twisting; section 5 handles clearing and gassing; section 6 concerns reeling, preparing, and making up; section 7 deals with threads and their manufacture; and section 8 discusses costs, waste and organization. The work is doubly valuable, first because of the fact that the author is a recognized authority on the subject, and, secondly, because there is a decided scarcity of published matter concerning this field of manufacture. (The work is reviewed by the Journal Textile Institute, Vol. 22 - 6, June, 1931, pp. P116. (S)

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AN INDEX OF PATENTED MOTHPROOFING MATERIALS.- R. C. Roark.
Insecticide Div., Bureau of Chemistry and Soils, U. S. Dept. of Agriculture, Washington, D. C. May, 1931. Mimeo. pp. 125.

The materials listed not only include those that have been patented, or that are the bases of patented mothproofing materials, but also those that have been tested and found effective or ineffective. Fumigants are not included. It is stated that most of the effective mothproofing materials are stomach poisons, which kill the young clothes moth larvae when ingested. The annual loss caused by clothes moths, carpet beetles, furniture beetles and similar insects is conservatively estimated at $100,000,000 for the United States alone.

The domestic and foreign patents and publications consulted in compiling the list of materials are appended. (C)

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RAYON PATENTS.- Dr. K. Suevern.
Julius Springer, Berlin, Germany. 1931. pp. 642.

Covers rayon patents of all countries issued during 1926-28. Available only in German. (C)

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GOVERNMENT PUBLICATIONS RELATING TO TEXTILES.
Department of Commerce Bulletin. (1931)

A pamphlet compiled of the publications on textile subjects issued by Government Bureaus. (S)

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MANUAL OF THE TEXTILE INDUSTRY OF CANADA.
Canadian Textile Journal Publishing Co.,Ltd., Montreal. (1931 edition)

The volume presents interviews with leading authorities of the Canadian Textile Industry together with a series of articles and statistics covering the development and production for the year. (S)

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